The Emerging Promise of the Routine Sub-mSv Exam: *Just How Close Are We*?

GE Healthcare

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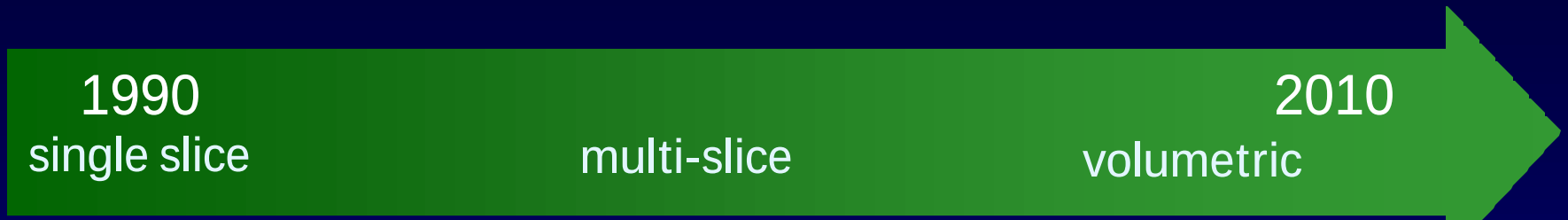
GE Dose Reduction Technology



- Dynamic Projection Filter
- Z-smoothing Filter
- Smart-Prep
- Collimator Tracking
- Auto-mA
- Smart-mA
- Neuro-Filter
- EKG-mA-modulation
- Color Code for Kids
- Backlit Diode
- Collection Cup
- Snap-shot Pulse
- ASiR
- Helical Shuttle
- Helical Shutter
- MBIR (Veo)
- Photon-counting CT

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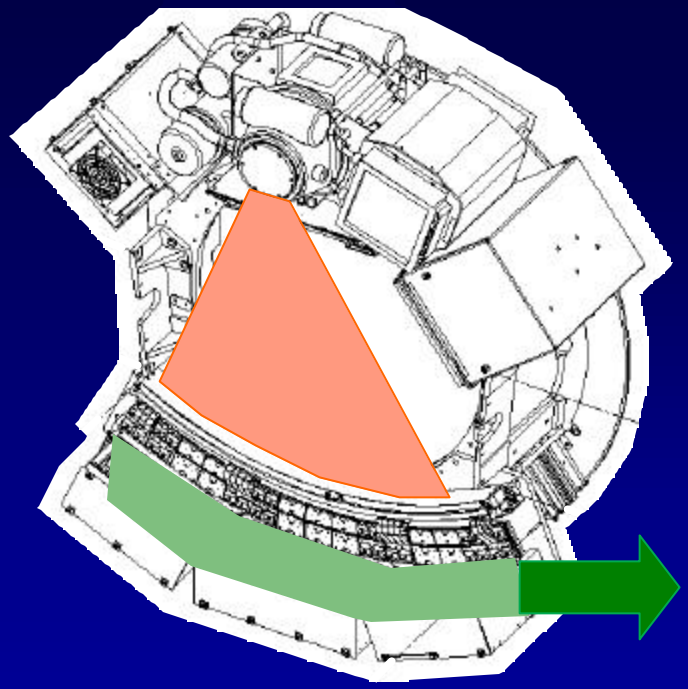
Filtered Backprojection vs. Iterative Reconstruction



- FBP was used over the past 30+ years
- Closed form analytical solution for speed
- Ignore noise in the system

$$f(x,y,z)=\int_{b_{\min}}^{b_{\max}}\frac{R^2}{L^2(x,y,b)}w(g,b,a)\int_{-\infty}^{\infty}h(g'-g)p(g,b,a)dgdb$$

- Iterative reconstruction solve the problem in a iterative fashion
- Allows the incorporation of more complex statistical models

$$\hat{x}=\arg\min_{x}\{L(Ax,y)+aG(x)\}$$

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ASiR Dose Reduction

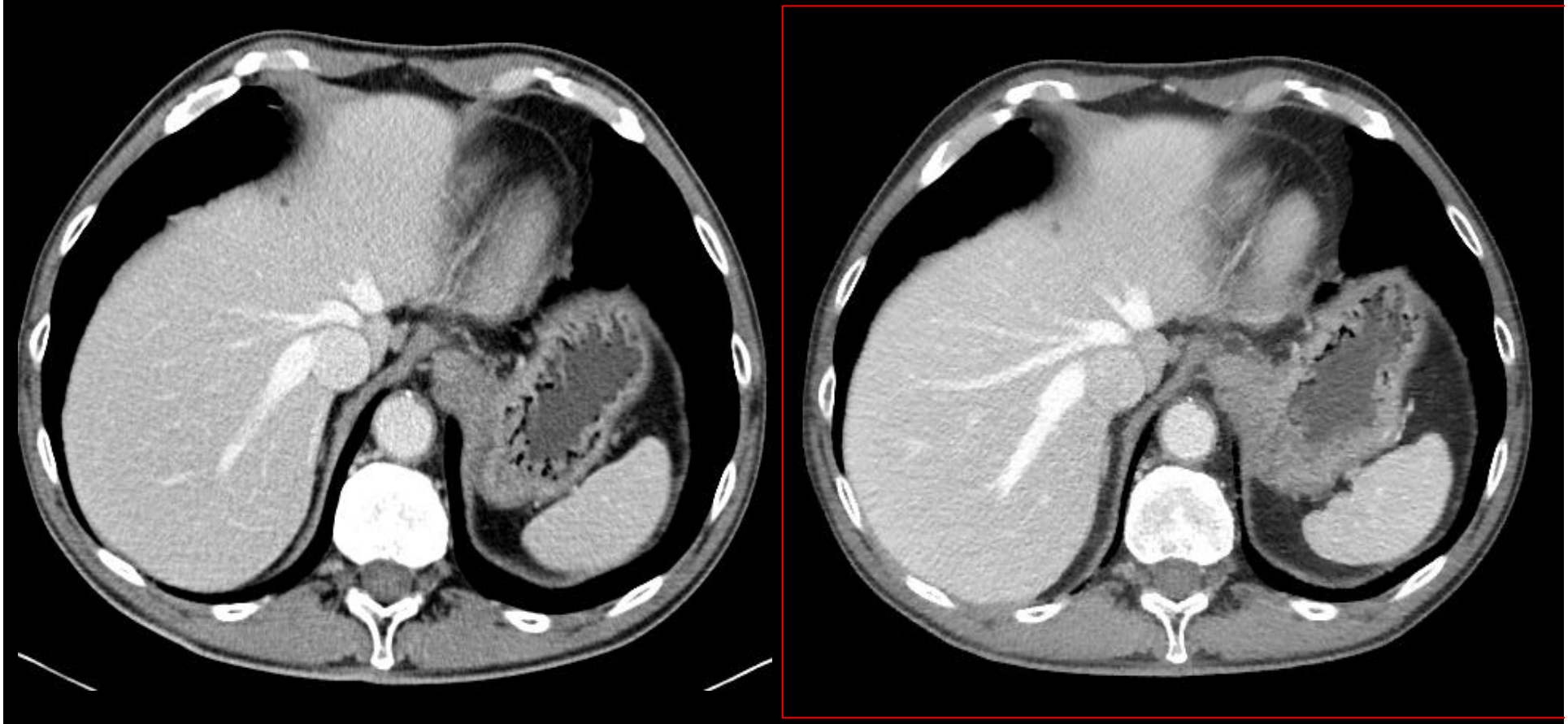
Discovery 750HD

FBP

1/18/08

ASIR

8/1/08



CTDI = 19

CTDI = 6

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Images courtesy of Dr. Hara of Mayo Clinic, Scottsdale

ASiR Dose Reduction

FBP

CTDI = 14.28

ASIR

CTDI = 4.95

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Images courtesy of Dr. Hara of Mayo Clinic, Scottsdale

Iterative Reconstruction

- Iterative reconstruction technology offers significant dose reduction without compromising image quality.
- Since its introduction a few years ago, ASiR has been available:
  - Discovery CT750 HD: available since 2008
  - LightSpeed VCT: available since 2009
  - BrightSpeed Elite: available outside US since 2009
  - Discovery CT590 RT: 510k pending, available outside US since 2010
  - Optima CT660: 510k pending, available outside US since 2010
  - Optima CT580: 510k pending, available outside US since 2010
- Can we bring iterative reconstruction technology to the next level?

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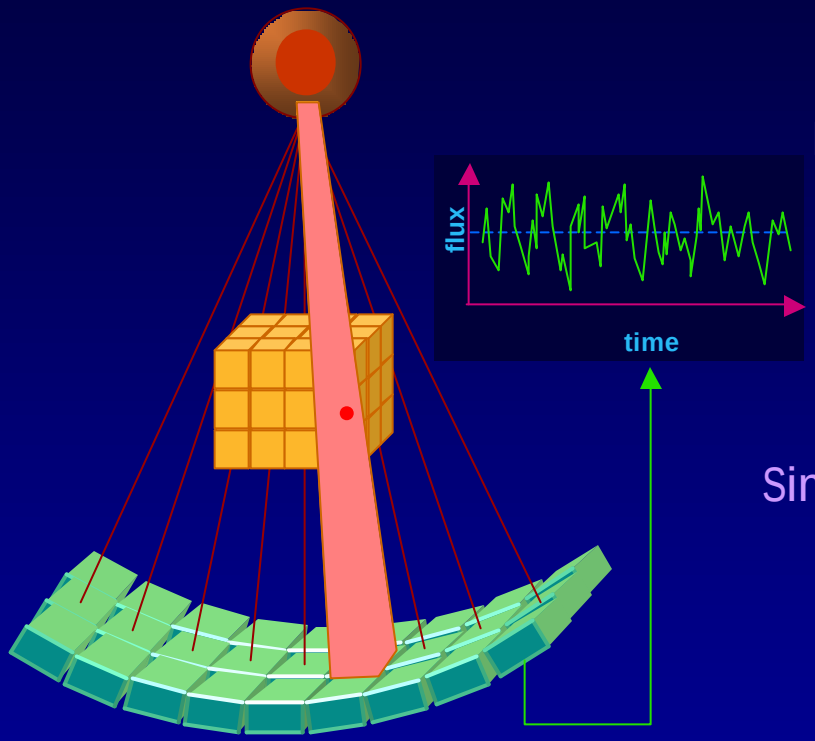
Filtered Backprojection vs. Model-based Iterative Reconstruction



FBP		MBIR (Veo)
Point Focal Spot	→	Real Focal Spot
Point Detector	→	Real Detector
Point Voxel	→	Cubic Voxel
Pencil Beam	→	Broad Beam
Perfect Sample	→	Statistical Model
Line Integral	→	Physics Model
Simple Calculation	→	Complex Computation
Simplicity	→	Image Quality

$$f(x,y,z)=\int_{b_{\min}}^{b_{\max}}\frac{R^2}{L^2(x,y,b)}w(g,b,a)\int_{-\infty}^{\infty}h(g'-g)p(g,b,a)dgdb$$

$$\hat{x}=\arg\min_x\{L(Ax,y)+aG(x)\}$$

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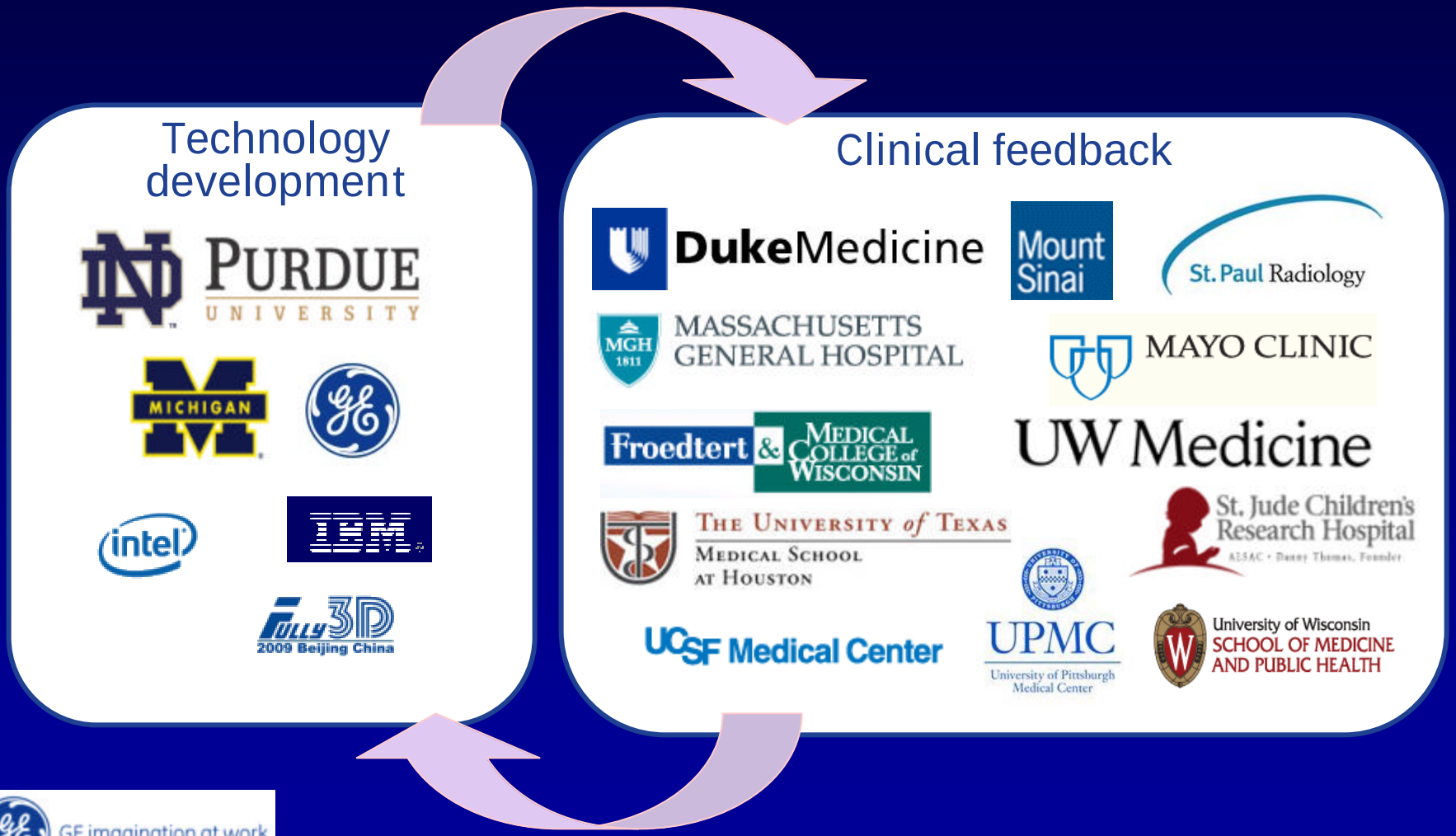
Veo is 510(k) pending. Not available for sale in the U.S.

MBIR technology development

Strong collaborations feed innovation cycle



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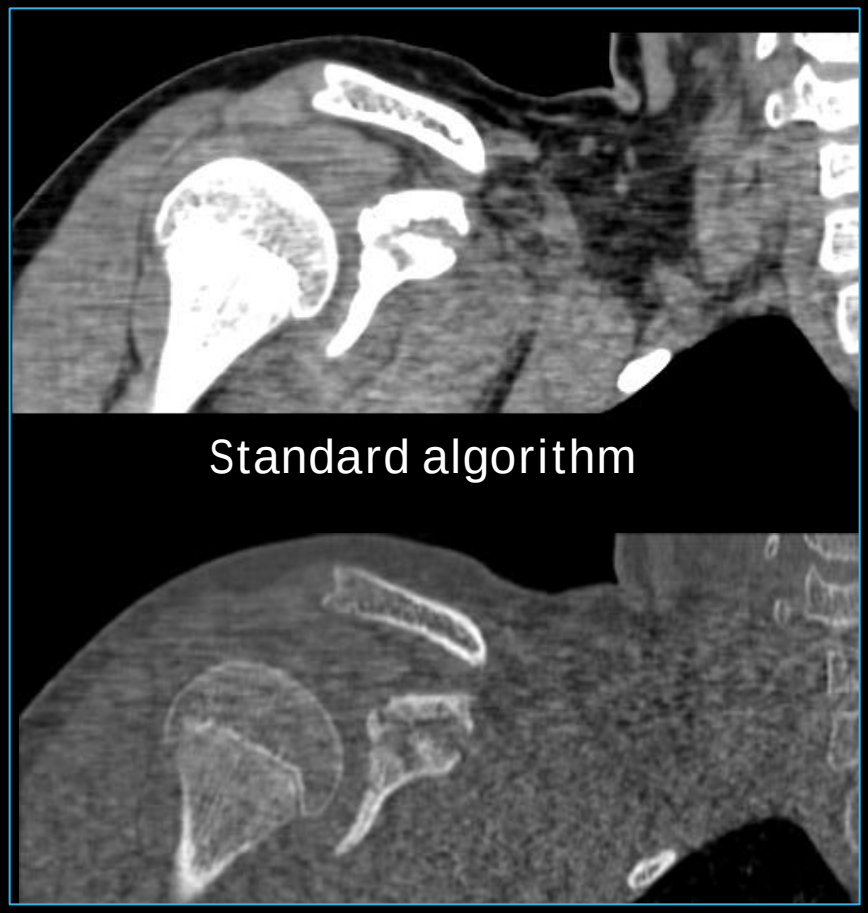
High Resolution and Low Noise

FBP

Veo (MBIR)



Standard algorithm

WW 350 WL 50

Bone Plus algorithm

WW 2000 WL 400

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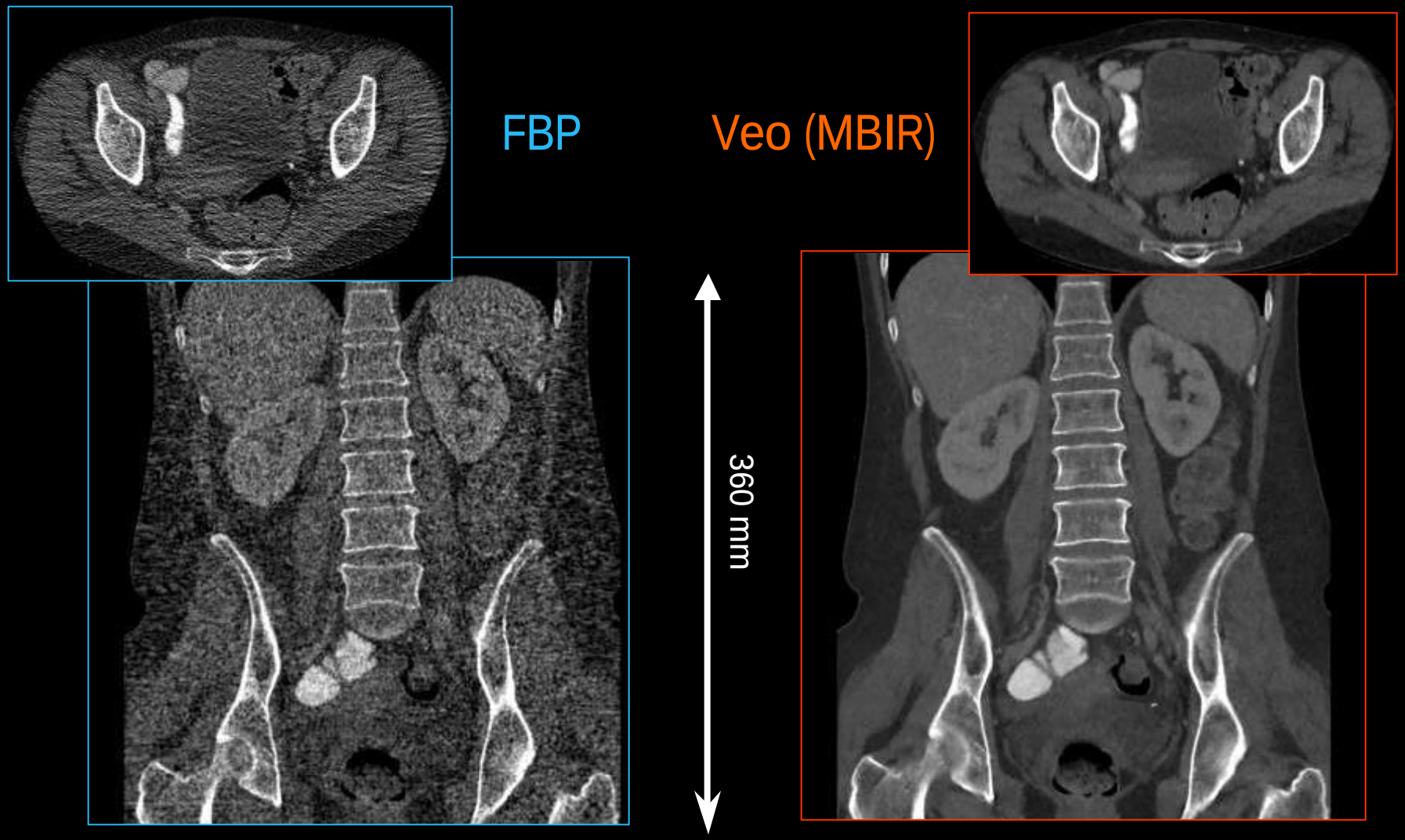
Routine Abdomen Pelvis *dose - 0.77 mSv**



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*Obtained by EUR-16262 EN, using an abdomen factor of 0.015*DLP and a pelvis factor of 0.019*DLP

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Routine Abdomen Pelvis *dose - 0.68 mSv**

FBP

Veo (MBIR)

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*Obtained by EUR-16262 EN, using an abdomen factor of 0.015*DLP and a pelvis factor of 0.019*DLP

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Routine Abdomen Pelvis *dose - 0.6 mSv**

FBP

Veo (MBIR)

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*Obtained by EUR-16262 EN, using an abdomen factor of 0.015*DLP and a pelvis factor of 0.019*DLP

Veo is 510(k) pending. Not available for sale in the U.S.

Routine Abdomen Pelvis *dose - 0.6 mSv**

FBP

Veo (MBIR)

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*Obtained by EUR-16262 EN, using an abdomen factor of 0.015*DLP and a pelvis factor of 0.019*DLP

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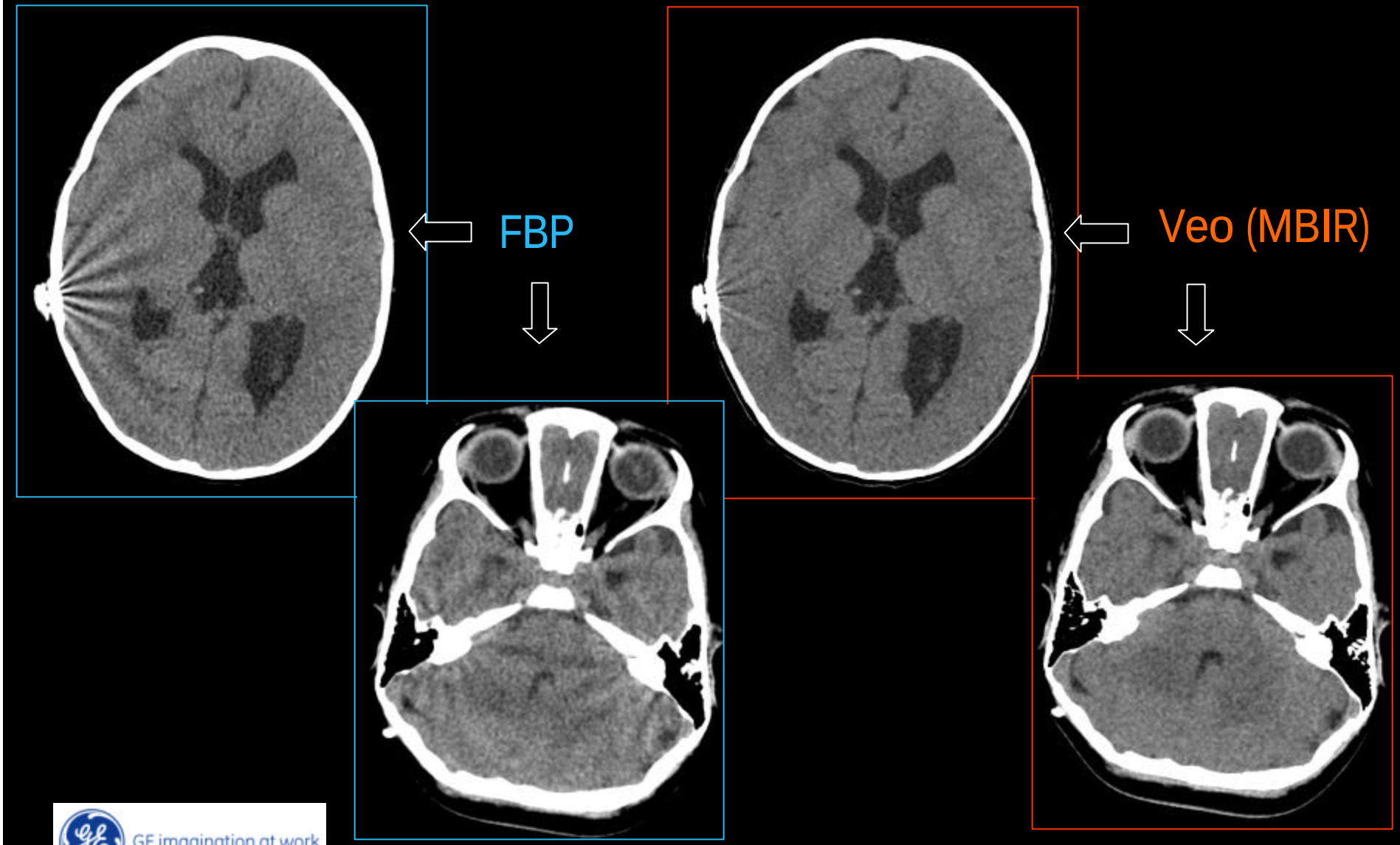
Routine Head *dose - 0.5 mSv**



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Veo is 510(k) pending. Not available for sale in the U.S.

* Obtained by EUR-16262 EN, using a head factor of 0.0023*DLP

Routine Chest CT *dose - 0.09 mSv**

"Typical CXR effective dose is about 0.06 mSv."

Source: Health Physics Society.
http://www.hps.org/publicinformation/ate/q2372.html

FBP

Veo (MBIR)

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Areas Government Agencies Can Help

- Supporting advanced reconstruction technology
  - SW acceleration
  - HW acceleration
- Supporting next generation scanner technologies
  - Photon Counting detectors (optimal energy weighting, improved energy resolution, zero electronic noise)
  - Advanced scanner concept (inverse geometry, etc)
- Support clinical studies
  - Protocol optimization
  - Multi-center studies
- Timely clearance of FDA 510k on dose reduction technologies

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Conclusion

- Dose reduction has been one of the key CT technology drivers for the past two decades.
- The continued development of iterative reconstruction technology will likely to fundamentally change the operation of a CT scanner (ASiR: 800+ sites global with 5 million patients, Veo: 510k pending)
- Dose reduction is a journey and requires the participation from CT manufactures, CT physicists, CT operators, radiologists, professional organizations, and government agencies.

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